9 ESTIMATION OF RELEASE RATES FOR ALTERNATIVE SCENARIOS FOR FLAMMABLE SUBSTANCES

In Chapter 9

- Methods to estimate a release rate to air for a flammable gas (9.1) or liquid (9.2).

9.1 Flammable Gases

Gaseous Release from Tank or Pipe

An alternative scenario for a release of a flammable gas may involve a leak from a vessel or piping. To estimate a release rate for flammable gases from hole size and storage conditions, you may use the method described above in Section 7.1.1 for toxic gases. This release rate may be used to determine the dispersion distance to the lower flammability limit (LFL), as described in Section 10.1. Exhibit C-2 in Appendix C includes Gas Factors (GF) that may be used in carrying out the calculations for each of the regulated flammable gases.

Example 26. Release Rate of Flammable Gas from Hole in Tank (Ethylene)

A pipe tears off a tank containing ethylene. The pipe is in the vapor space of the tank. The release rate from the hole can be estimated from Equation 7-1 in Section 7.1. You estimate that the pipe would leave a hole with an area (HA) of 5 square inches. The temperature inside the tank (T_t , absolute temperature, Kelvin) is 282 K, 9°C, and the square root of the temperature is 16.8. The pressure in the tank (P_t) is approximately 728 pounds per square inch absolute (psia). From Exhibit C-2, Appendix C, the gas factor (GF) for ethylene is 18. From Equation 7-1, the release rate (QR) is:

$$QR = 5 \times 728 \times (1/16.8) \times 18 = 3{,}900 \text{ pounds per minute}$$

Gases Liquefied Under Pressure

A vapor cloud fire is a possible result of a release of a gas liquefied under pressure. You may use the methods described in Section 7.1.1 for toxic gases liquefied under pressure to estimate the release rate from a hole in a tank for a flammable gas liquefied under pressure. The estimated release rate may be used to estimate the dispersion distance to the LFL for a vapor cloud fire.

Flammable gases that are liquefied under pressure may be released very rapidly, with partial vaporization of the liquefied gas and possible aerosol formation. Section 10.4 presents a method for estimating the consequences of a vapor cloud explosion from such a release of a gas liquefied under pressure.

Gases Liquefied by Refrigeration

Flammable gases liquefied by refrigeration alone can be treated as liquids for the alternative scenario analysis, as discussed in Section 9.2 and Section 10.2, below.

9.2 Flammable Liquids

You may estimate a release rate for flammable liquids by estimating the evaporation rate from a pool. Release rates also can be estimated for flammable gases liquefied by refrigeration alone by this method, if the liquefied gas is likely to form a pool upon release. You first need to estimate the quantity in the pool.

You may use the method discussed in Section 7.2.1 to estimate a rate of liquid release for flammable liquids into a pool from a hole in a tank or from a pipe shear. Exhibit C-3 in Appendix C includes liquid leak factors (LLF) for calculating release rate from a hole. Note that the LLF is appropriate only for atmospheric tanks. LLF values are not provided for liquefied flammable gases; you will need to estimate the quantity in the pool from other information for liquefied flammable gases.

Once you have an estimate of the quantity of flammable liquid in a pool, you may use the methods presented in Section 7.2.3 to estimate the evaporation rate from the pool. Liquid factors at ambient and boiling temperature (LFA and LFB) for liquids for the calculation are listed in Exhibit C-3 in Appendix C, and LFBs for liquefied gases are listed in Exhibit C-2. Both passive and active mitigation measures (discussed in Sections 7.2.2 and 7.2.3) may be taken into account. You do not need to estimate the duration of the release, because this information is not used to estimate distance to the LFL, as discussed in the next chapter.

As for toxic liquids, if the rate of evaporation of the liquid from the pool is greater than the rate of release of the liquid from the container, you should use the liquid release rate, not the pool evaporation rate, as the rate of release to the air. You should expect rapid evaporation rates for liquefied flammable gases from a pool. All of the regulated flammable liquids are volatile, so the evaporation rate from a pool may be expected to be relatively high, particularly without mitigation.